Petroleum industry of California,
by R.P. McLaughlin, assited by C.A. Waring,
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F. McN. Hamilton, state mineralogist.

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# PETROLEUM INDUSTRY
OF
# CALIFORNIA

**MAP FOLIO**
ACCOMPANYING
**BULLETIN No. 69**

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**CALIFORNIA STATE MINING BUREAU**
FERRY BUILDING - - SAN FRANCISCO
1914

COMPLIMENTS OF
F. MON HAMILTON
STATE MINERALOGIST

# GEOLOGIC AND OIL FIELD MAPS AND DRAWINGS

Accompanying Bulletin 69

## "PETROLEUM INDUSTRY OF CALIFORNIA"

by

R. P. McLAUGHLIN, assisted by C. A. WARING.

CALIFORNIA STATE MINING BUREAU

FLETCHER McN. HAMILTON, State Mineralogist

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## The Geologic Record of California


JAMES PERRIN SMITH

Stanford University, Cal.



Extract from the Journal of Geology, Vol. XVIII, No. 3, April-May, 1910.


The geologic record of California is exceedingly complete for a single geographic region, because of the two ancient and persistent seas that covered some portion of its surface during each geologic period. These seas were the Pacific Ocean and the Great Basin Sea.

*Great Basin Sea.*—The older portion of the geologic record, from the Cambian to the top of the Middle Jurassic, has been preserved chiefly in the sediments of the Great Basin Sea, while during those ages that part of California which was afterward covered by the Pacific Ocean was either above water, or has had its sediments so much metamorphosed that their age is not positively determinable.

The Great Basin Sea of Paleozoic and early Mesozoic time covered approximately the area of the Great Basin of the present age, sometimes more, and sometimes less, dwindling away gradually from the noble expanse of the Carboniferous Sea to the shrunken remnant in early Mesozoic time. This basin at all times was directly connected with the Pacific Ocean, by a broad passage to the northwest; and during a part of the Paleozoic, especially during the period of the Coal Measures, it was joined to the Mississippian Sea. At all other times it was exclusively western, and the marine Triassic and Jurassic history of the United States is its peculiar property. It has played very much the same part in the geologic history of North America as the ancient Mediterranean or Tethys did in the history of Europe, though on a much smaller scale, since it was epicontinental, and not intercontinental. The Cambrian, Silurian, and Devonian sediments of California are mere fragments of little area and thickness, representing only a small part of the entire time of those ages. The Carboniferous, however, is fairly complete, all three major divisions being fully represented by marine faunas. The Triassic period is well represented; the Lower Triassic is nearly as good as the standard American section of Idaho; the Middle Triassic has both of the greater divisions, although the main portion is not nearly so complete as the standard section of the West Humboldt Range in Nevada. The Upper Triassic of California is the standard for this epoch in America, and compares very favorably with the rest of the world in the richness of its faunas, and the completeness of the record. The Jurassic section of the Great Basin Sea is the most complete in the United States, having portions of each stage from Lias to Kelloway, inclusive; but it is fragmentary, the faunas being poorly preserved and scanty. It is not comparable with the Jurassic record of Alaska and British Columbia, and nowhere approaching that of South America. With this epoch the marine column of the Great Basin ends abruptly, as the sea was obliterated at the beginning of the Cordilleran revolution.

*Pacific record.*—The marine record of California from the bottom of the Upper Jurassic through the Quaternary was kept exclusively by the Pacific Ocean. This was divided between two provinces or areas of sedimentation, the Sierra Nevada, and the Coast Ranges, but the distribution was not balanced. The Pacific province is one of the great geosynclines, with sediments approximating seventy thousand feet in thickness, and undergoing subsidence more or less continuously, though spasmodically, from the Triassic onward, interrupted by great periods of orogenic activity. This is a part of that grand structural feature of the continent of which the Great Valley, the Gulf of California, the Willamette Valley, and Puget Sound are mere remnants.

The recognizable Paleozoic and early Mesozoic sediments are confined to the Sierra Nevada, while the Cretaceous and Tertiary strata are most complete in the Coast Ranges. The Sierran record is fragmentary, the formations being incomplete, separated by great unconformities, including great masses of tuffs and igneous rocks, and showing evidence of important recurring orogenic and volcanic activity.

The Coast Range province, too, showed this same phenomenon in its Paleozoic and early Mesozoic sediments, but from the bottom of the Cretaceous to the middle of the Miocene conditions were more uniform, indicating moderately quiet advance and retreat of the sea, with minor unconformities, smaller masses of igneous intrusives, and outpourings of surface lavas. The Coast Range revolution, about the middle of the Miocene epoch, broke the monotony of this history, and for a time there was much mountain-making activity. Minor outpourings of lava occurred along the coast, while farther to the northeast the Columbian lava flood overwhelmed an area of about two hundred thousand square miles, and the rejuvenation of the Sierra Nevada was beginning.

The Cretaceous section of the Coast Ranges is more complete than that of any other single province in America. It lacks only the uppermost portion, and shows a variety of conditions not seen anywhere else, from the boreal faunas of the Knoxville to the tropical faunas of the Horsetown and Chico epochs, with fossil floras interbedded in every formation.

The Tertiary marine section of the Coast Ranges is not only the most complete in America, but also more complete than that of any other single geographic region in the world. Every minor division is fully represented by marine faunas, and most of them have freshwater beds intercalated, with fossil plants and freshwater animals.

The Quaternary marine section of the Coast Ranges is the most complete that has been described, for this is almost the only known region where there has been much Post-Quaternary orogenic activity. In nearly all other regions the Quaternary sediments are still buried under the oceans in which they were deposited.

### ROCK-FORMING AGENCIES OF CALIFORNIA.

*Igneous rocks.*—A large part of the surface of the state, a little less than one-half, is made up of igneous rocks. Of these the most important group consists of deep-seated granitic rocks, granites, grano-diorites, diorites, and gabbros, compounds of feldspars and ferro-magnesian minerals, such as hornblendes, pyroxenes, and mica. The greatest of these batholites is the great igneous mass of the Sierra Nevada, making up the bulk of that mountain chain. Smaller batholites of similar character are in the Sierra Madre Range, the White Mountain Range, the Klamath Mountains, and in the Santa Lucia Mountains.

Associated with the deep-seated granitic rocks in nearly all these regions there are numerous dyke-rocks, similar in chemical nature to the parent masses, but showing only a small surface area.

A second group is composed of basic intrusives, chiefly peridotites, now largely changed to serpentine, rich in olivine and other ferro-magnesian minerals. These cover great stretches in the Coast Ranges, where they are largely of Franciscan age, older than the Cretaceous; they also form less extensive masses in the Sierra Nevada.

A third group is composed of lavas, mostly andesites and basalts, surface flows from volcanoes. These are chiefly of Tertiary age, Middle Miocene, and together with the less important rhyolite flows, they cover broad areas in northeastern California, and smaller patches in all the other mountain regions of the state. The flows in northeastern California are a part of the Columbian field, and doubtless came from fissure-eruptions. The others came from ordinary volcanoes, though in most cases the volcanic cones are long since destroyed. Mt. Shasta and Lassen Peak are the two grandest volcanoes of the state, the southern extension of the Cascade Range, still preserving their ancient form and some feeble remnants of their old-time activity.

*Inorganic sediments.*—The greater part of the surface of California, a little more than half, is made up of sediments. These are of two groups, (1) inorganic, and (2) organic.

The inorganic sediments are far greater in thickness and areal extent, sandstones and shales, derived from the decay of crystalline rocks. The quartz and undecomposed feldspars furnished the sand grains, and the decomposed feldspars furnished the clay for the shales. The sandstones of California are remarkable for the large quantity they contain of undecomposed fragments of minerals derived from the igneous rocks, so that they more often arkose and greywacke than true sandstones.

Thick beds of aluminous shales, now largely changed to slates, are found in the Carboniferous and Jurassic rocks of the Sierra Nevada, and to a less extent in the Franciscan formation of the Coast Ranges. The Auriferous Slates also form the surface rocks of considerable areas in the Klamath Mountains.

Less altered shales are extensively developed in all the later formations of the state, from the Lower Cretaceous upward, althought not on such a grand scale as in the older periods.

The greatest individual mass of sediments in California is formed by the Quaternary and Pliocene fluviatile deposits of the Great Valley. This mass is about four hundred miles long by fifty in width, and is several thousand feet thick in the middle, thinning out toward the edges, surpassing the enormous mass of Tertiary sediments. These valley deposits have been bored to a depth of three thousand feet, without reaching bed-rock, but there are too few deep borings for an estimate of the average thickness to be possible.


(Continued on Inside of Back Cover.)


## Fossils Characteristic of California Formations

(SHOWN ON PLATE I.)

Specimens in Geological Collection at Stanford University. Figures are one-half natural size.

### JURASSIC.

1. *Pleuromya undulata* Davis. Right valve from the black slates at Slate's Springs, Monterey Co., California. These slates have been thought to be of the same age as the Mariposa slates of the Sierra Nevada mountains, from which fossils numbers two and three are figured. Collected by F. M. Anderson in 1908.

2. *Cardioceras alternans* Buch. From the Mariposa slates (middle upper Jurassic) at Texas Charlie's ranch, six miles east of Copperopolis, Calaveras Co., California. Associated with *Aucella erringtoni*. Collected by Dr. J. P. Smith in 1913.

3. *Aucella erringtoni* Meek. Left valve from the Mariposa slates (middle upper Jurassic) at Texas Charlie's ranch, six miles east of Copperopolis, Calaveras Co., California. Associated with *Cardioceras alternans*. Collected by Dr. J. P. Smith in 1913.

### KNOXVILLE (Lower Cretaceous).

4. *Aucella crassicollis* Keyserling. From the Knoxville formation along ridge north of Dry Creek, Pleasanton quadrangle, Alameda Co., California. Collected by F. W. Nobs.

5. *Rhynchonella whitneyi* Gabb. From the Knoxville formation at Sulphur Creek, Colusa Co., California. Collected by Miss E. Welsh.

### HORSETOWN (Middle Cretaceous).

6. *Desmoceras ishikawai* Jimbo. From the upper Horsetown formation at Texas Springs, Shasta Co., California. Collected by Dr. J. P. Smith.

7. *Pecten operculiformis* Gabb. From the Horsetown formation south of Carnegie, Tesla quadrangle, Alameda Co., California. This species is found also at Texas Springs, Shasta Co. Collected by C. A. Waring.

8. *Phylloceras shastalense* F. M. Anderson. From the Horsetown formation south of Tesla, Alameda Co., California. This species is found also at Texas Springs, Shasta Co. Collected by C. A. Waring, July, 1913.

### CHICO (Upper Cretaceous).

9. *Baculites chicoensis* Trask. From the Chico formation, 200 yards north of the Spring Valley Water Company's dam site in Arroyo del Valle, Tesla quadrangle, Alameda Co., California. Collected by A. T. Schwennesen and C. A. Waring, July, 1913.

10. *Arca breweriana* Gabb. Left valve from the upper Chico formation one and one-half miles west of Tesla, Alameda Co., California. Collected by C. A. Waring, July, 1913.

11. *Placenticeras sanctae monicae* n. sp. Waring. From the Chico formation four miles northwest of Santa Monica, Los Angeles Co., California. Collected by B. E. Parsons in July, 1910. Named after the city of Santa Monica.

### MARTINEZ (Lower Eocene).

12. *Venericardia planicosta var. venturensis* Waring. Right valve from the Martinez formation three miles northeast of Simi Peak, Calabasas quadrangle, Ventura Co., California. Collected by B. E. Parsons in 1910. Distinguished from *V. horni* by its square ribs and comparative greater height.

13. *Pholadomya nasuta* Gabb. Left valve from the Martinez formation at Lower Lake, Lake Co., California. University of California locality 784. Collected by Roy E. Dickerson in 1912.

14. *Cardium breweri* Gabb. Left valve from the Martinez formation southwest of Santa Susana, Ventura Co., California. Collected by C. A. Waring, May, 1914.

14. *Turritella macreadyi* n. sp. Waring. From the Martinez formation three miles northeast of Simi Peak, Ventura Co., California. Collected by Geo. McCready in 1910, after whom it is named. This species is very characteristic of the Martinez of the Simi Hills.

16. *Brachysphingus sinuatus* Gabb. From the Martinez formation three miles northeast of Simi Peak, Ventura Co., California. Collected by H. L. Small in 1910.

### TEJON (Middle Eocene).

17. *Rimella canalifera* Gabb. From the Tejon formation near the oil wells of the Santa Susana Syndicate, Ventura Co., California. Collected by J. O. Lewis.

18. *Venericardia planicosta var. horni* Gabb. Right valve from the Tejon (Olequa and Chehalis) formation at Little Falls, Washington. Collected by H. Hannibal in 1912. A very characteristic species in the Tejon of California. Distinguished by its broad rounded ribs and large, elongate form.

19. *Turritella uvasana* Gabb. From the Tejon formation exposed in Tassajara Canyon, Contra Costa Co., California. Collected by A. T. Schwennesen and C. A. Waring in August, 1913.

20. *Morio tuberculatus* Gabb. From the Tejon (Chehalis) formation of the bluffs along the Cowlitz River below the mouth of Drew Creek, Washington. Collected by H. Hannibal and W. O. Clark. A characteristic species of the Tejon throughout California.

21. *Turritella andersoni* Dickerson. From the Tejon formation near the oil wells of the Santa Susana Syndicate (old McCray wells), Ventura Co., California. Collected by R. B. Moran.


(Continued on Inside of Back Cover.)

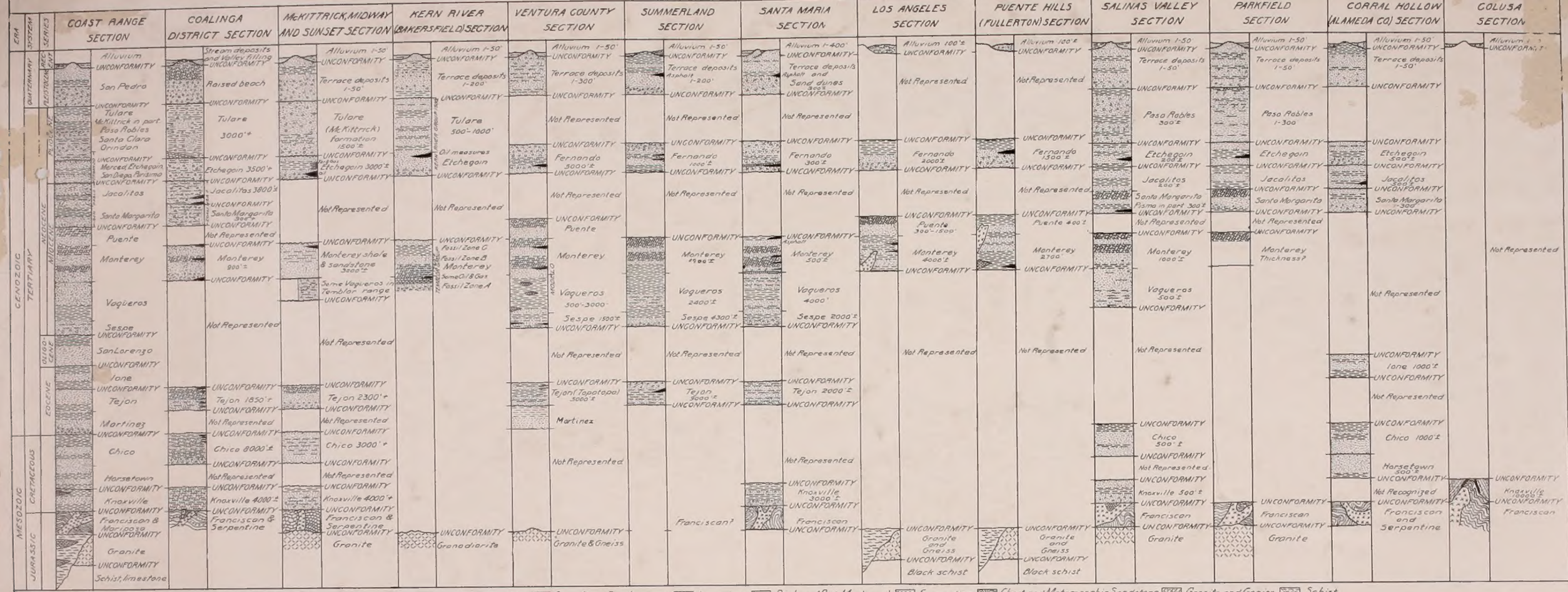
California State Mining Bureau
F McN Hamilton. State Mineralogist

# CORRELATION OF GEOLOGIC FORMATIONS OF CALIFORNIA COAST RANGE

(SHOWING OIL HORIZONS AND CHARACTERISTIC FOSSILS)

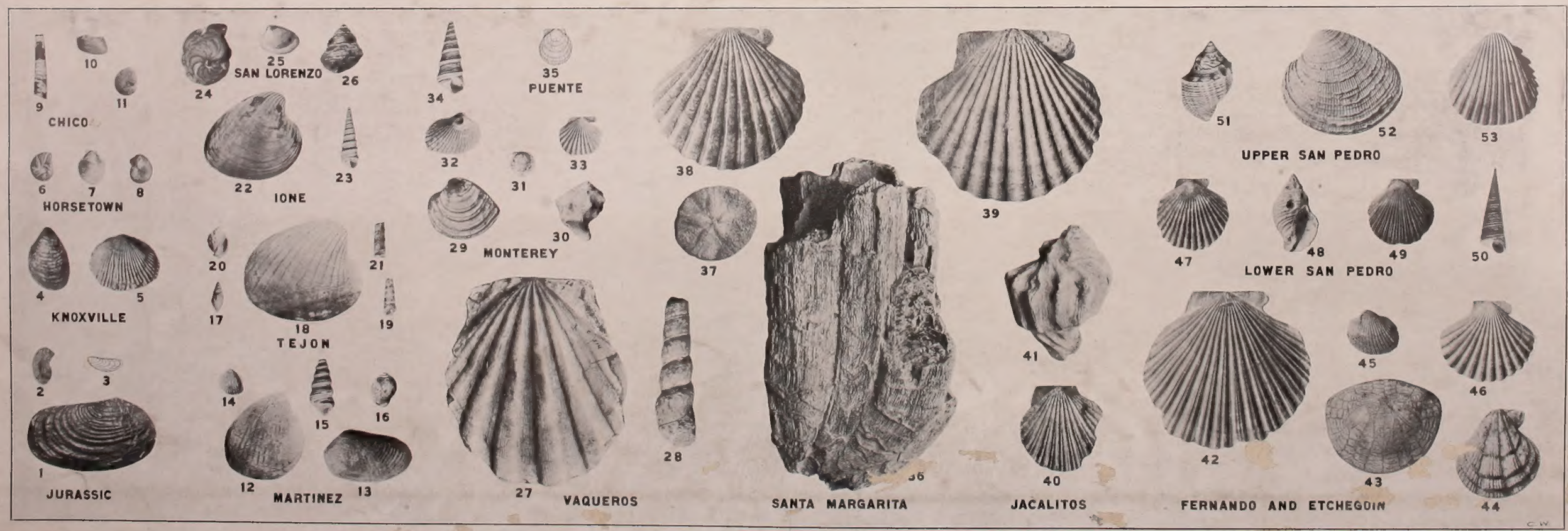
Compiled by
R P McLaughlin and C A Waring

Plate. I




## FOSSILS CHARACTERISTIC OF CALIFORNIA FORMATIONS

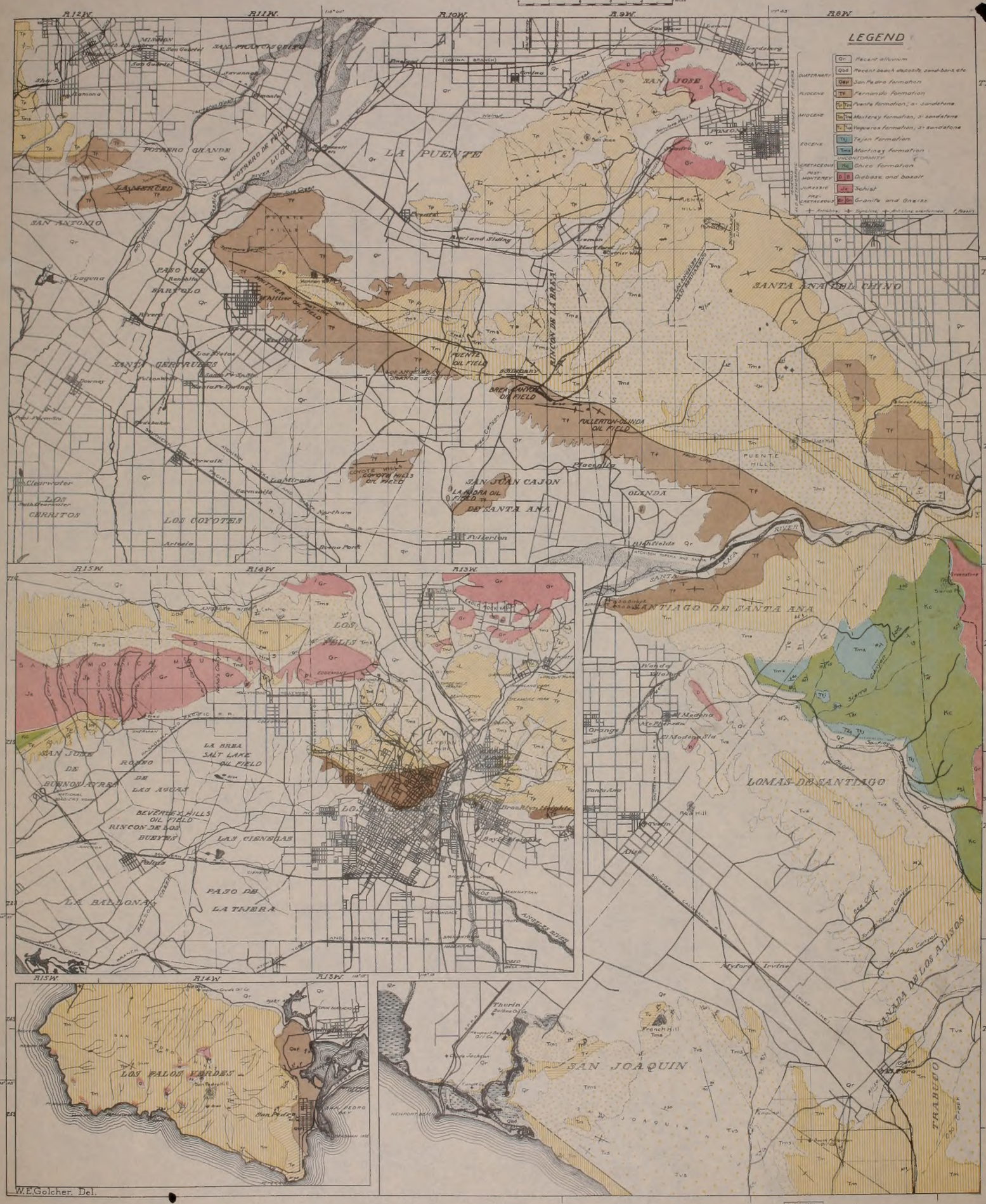
Specimens in the Geological Collection of Stanford University.
Figures One-Half Natural Size.



California State Mining Bureau
F.M.N. Hamilton State Mineralogist
R.P. McLaughlin Chief of Petroleum Dept.

Plate. II

# GEOLOGIC MAP OF PORTIONS OF
# LOS ANGELES AND ORANGE COUNTIES
1914



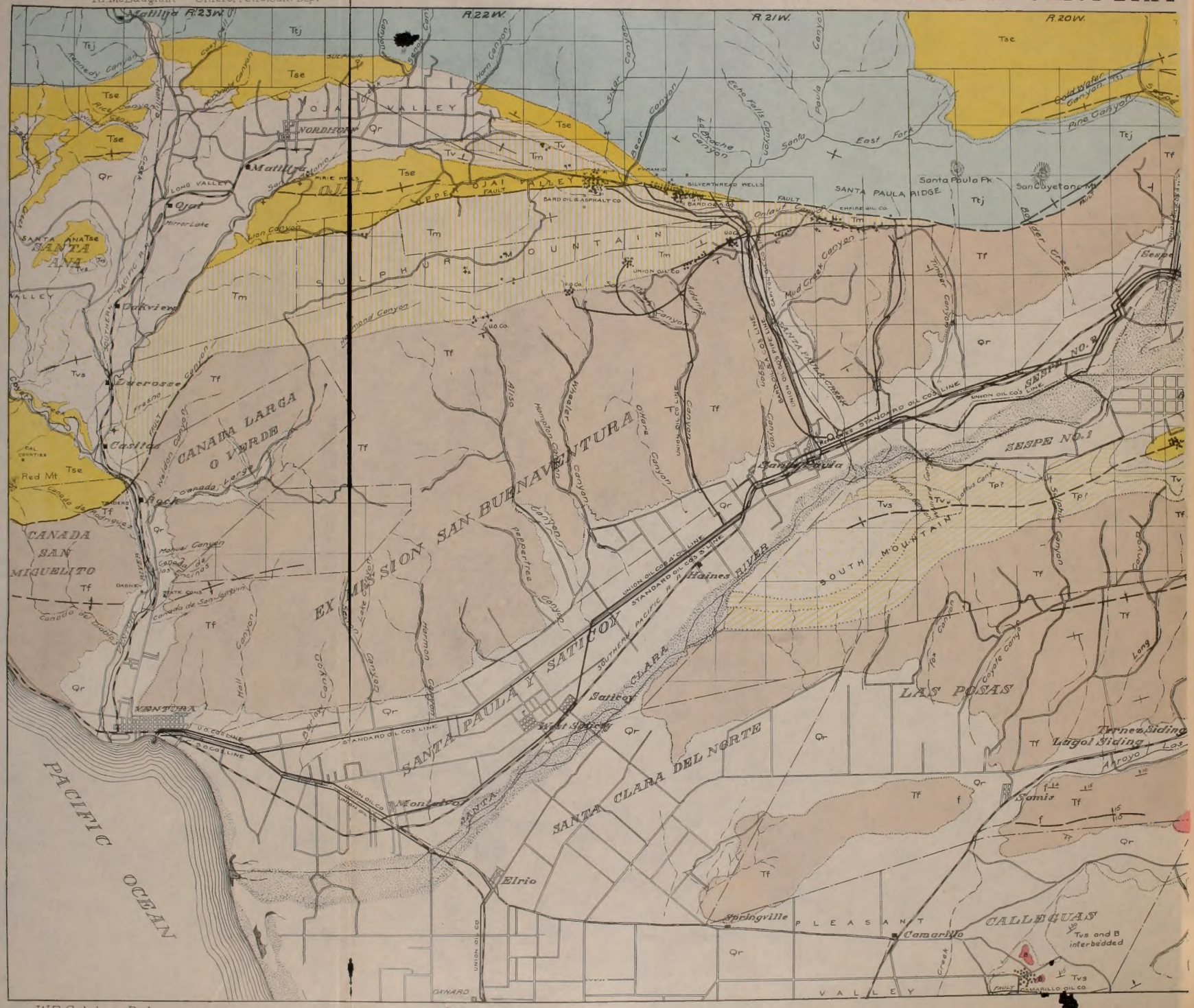

W.E. Golcher, Del.

Compiled by C.A. Waring.

Plate III

California State Mining Bureau
F.McN.Hamilton State Mineralogist
R.P.McLaughlin Chief of Petroleum Dept

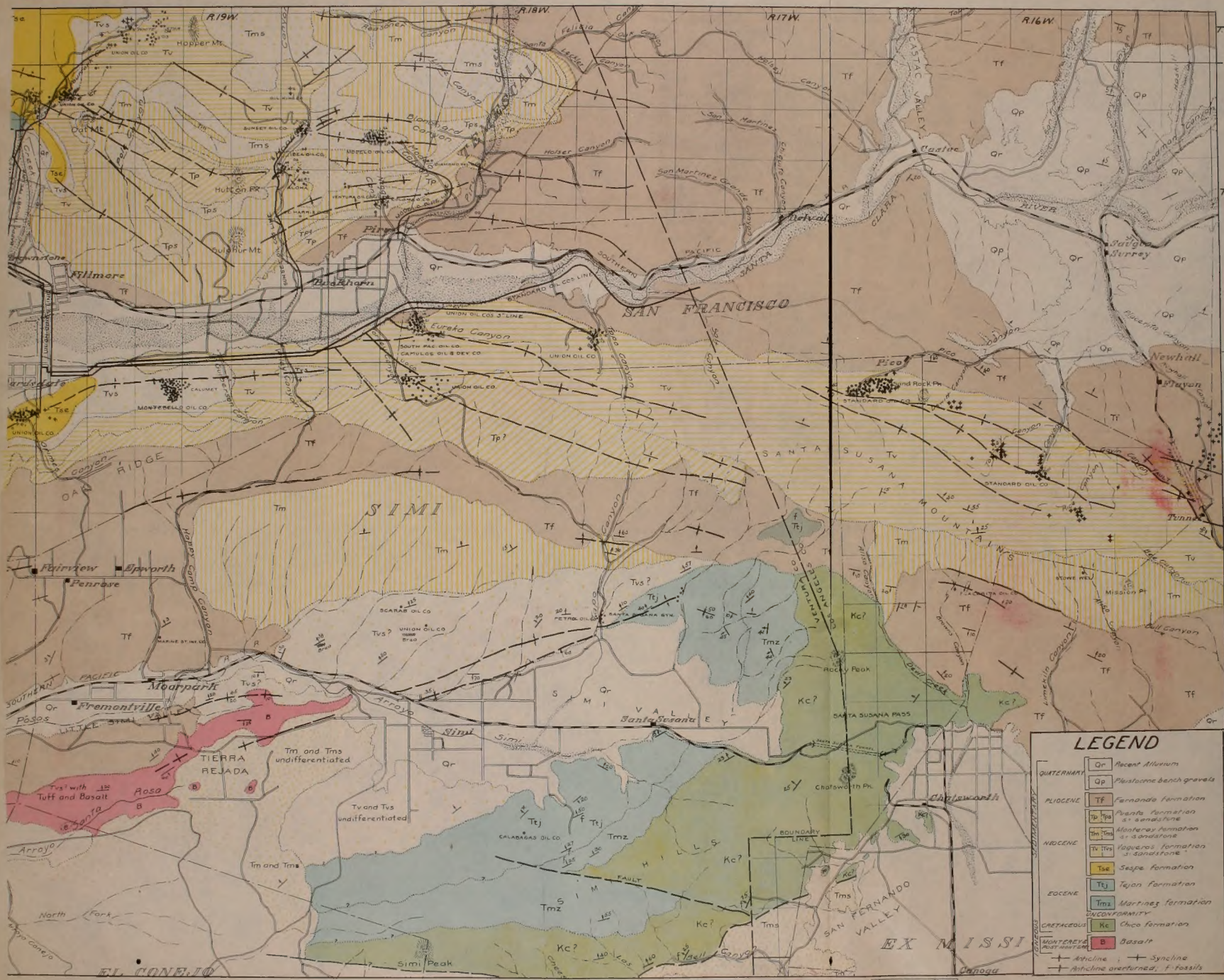
# GEOLOGIC MAP OF PORTIONS OF VENTURA




WE Golcher, Del.

# AND LOS ANGELES COUNTIES

Plate. III




Compiled by C.A.Waring.

California State Mining Bureau.
F.McN.Hamilton State Mineralogist
R.P.McLaughlin Chief of Petroleum Dept.

# GEOLOGIC MAP OF PORTIONS OF MON

W.E.Golcher, Del.

# F MONTEREY AND SAN LUIS OBISPO COUNTIES

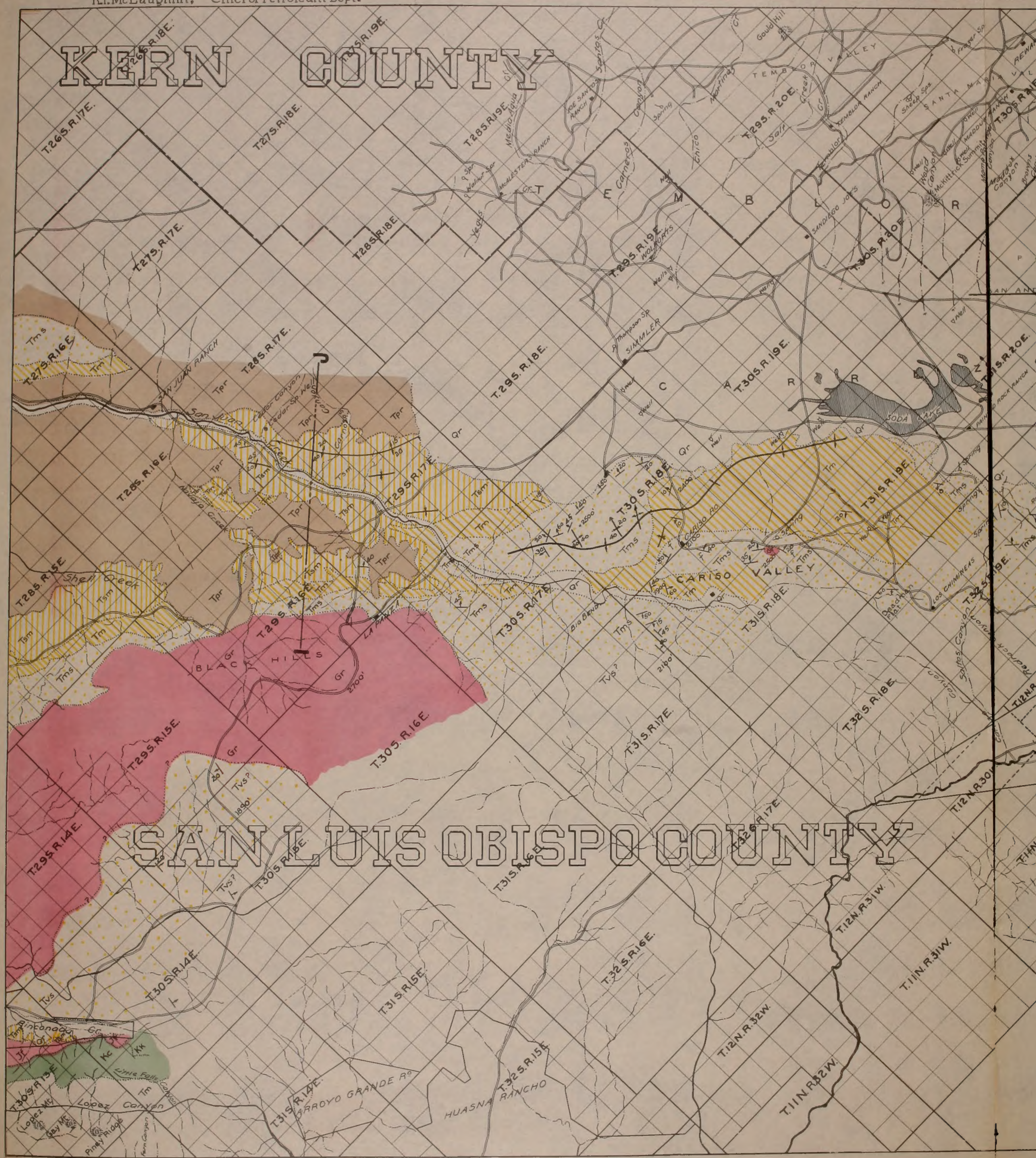
Plate. IV

See Legend Plate V.

Compiled by C.A.Waring.

California State Mining Bureau
F.McN.Hamilton, State Mineralogist.
R.P.McLaughlin, Chief of Petroleum Dept.

# GEOLOGIC MAP OF PORTIONS OF




W.E.Golcher, Del.

# OF SAN LUIS OBISPO AND KERN COUNTIES.

Plate V

## LEGEND

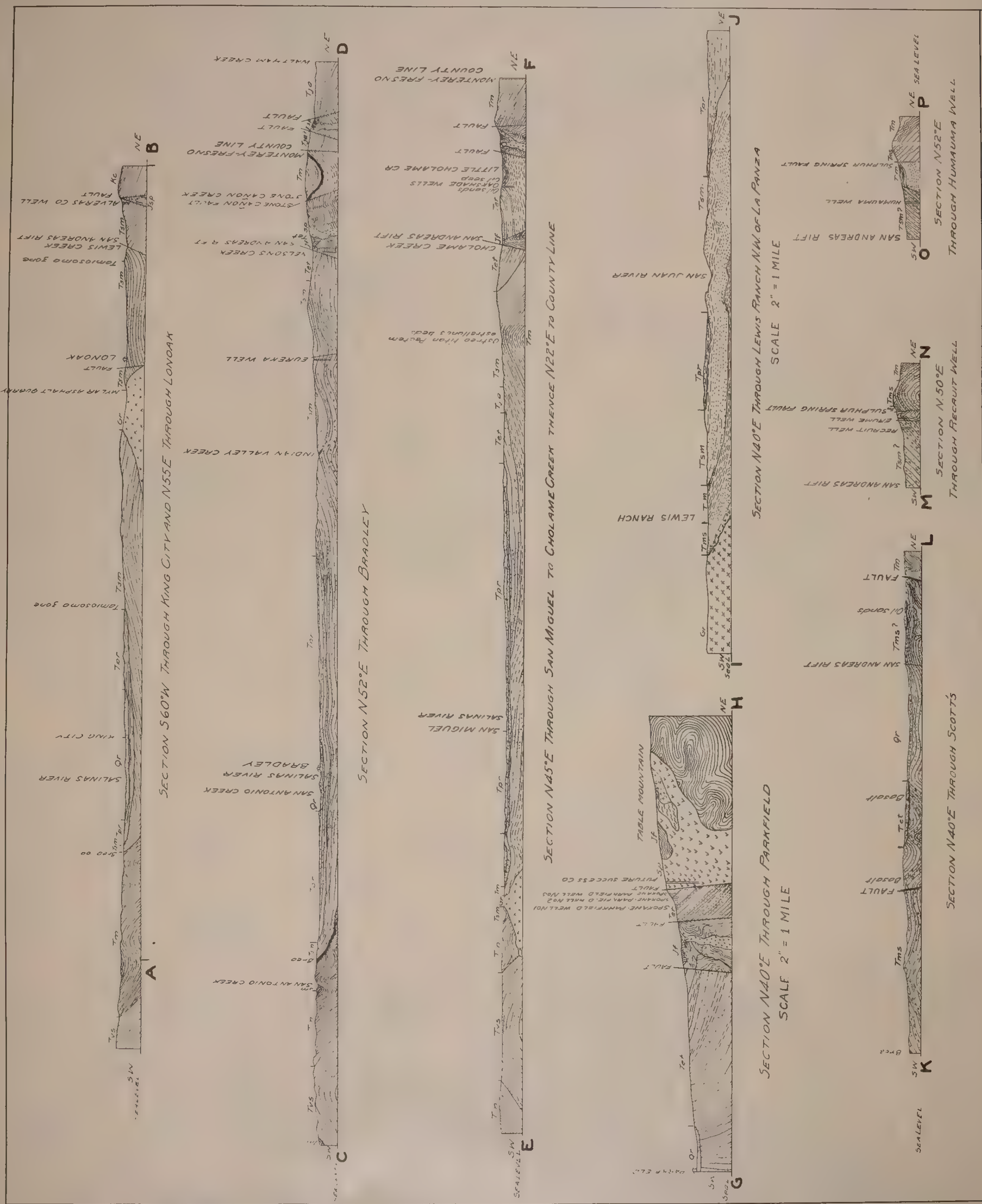
| | | |
|---|---|---|
| QUATERNARY | Qr | Recent alluvium |
| | Qp | Pleistocene terrace deposits |
| PLIOCENE | Tpr | Paso Robles formation |
| | Tet | Etchegoin formation |
| | Tjo | Jacalitos formation |
| | Tsm | Santa Margarita formation |
| MIOCENE | UNCONFORMITY | |
| | Tm Tms | Monterey formation (shale, sandstone, limestone) |
| | Tv Tvs | Vaqueros formation (sandstone) |
| CRETACEOUS | Kc | Chico formation |
| | Kk | Knoxville formation |
| JURASSIC | Jf | Franciscan formation |
| | D B | Diabase and Gabbro |
| IGNEOUS | Sp | Serpentine |
| | Gr Gn | Granite and Gneiss |

Compiled by C. A. Waring.

California State Mining Bureau
F.McN Hamilton State Mineralogist
R.P.McLaughlin Chief of Petroleum Dept

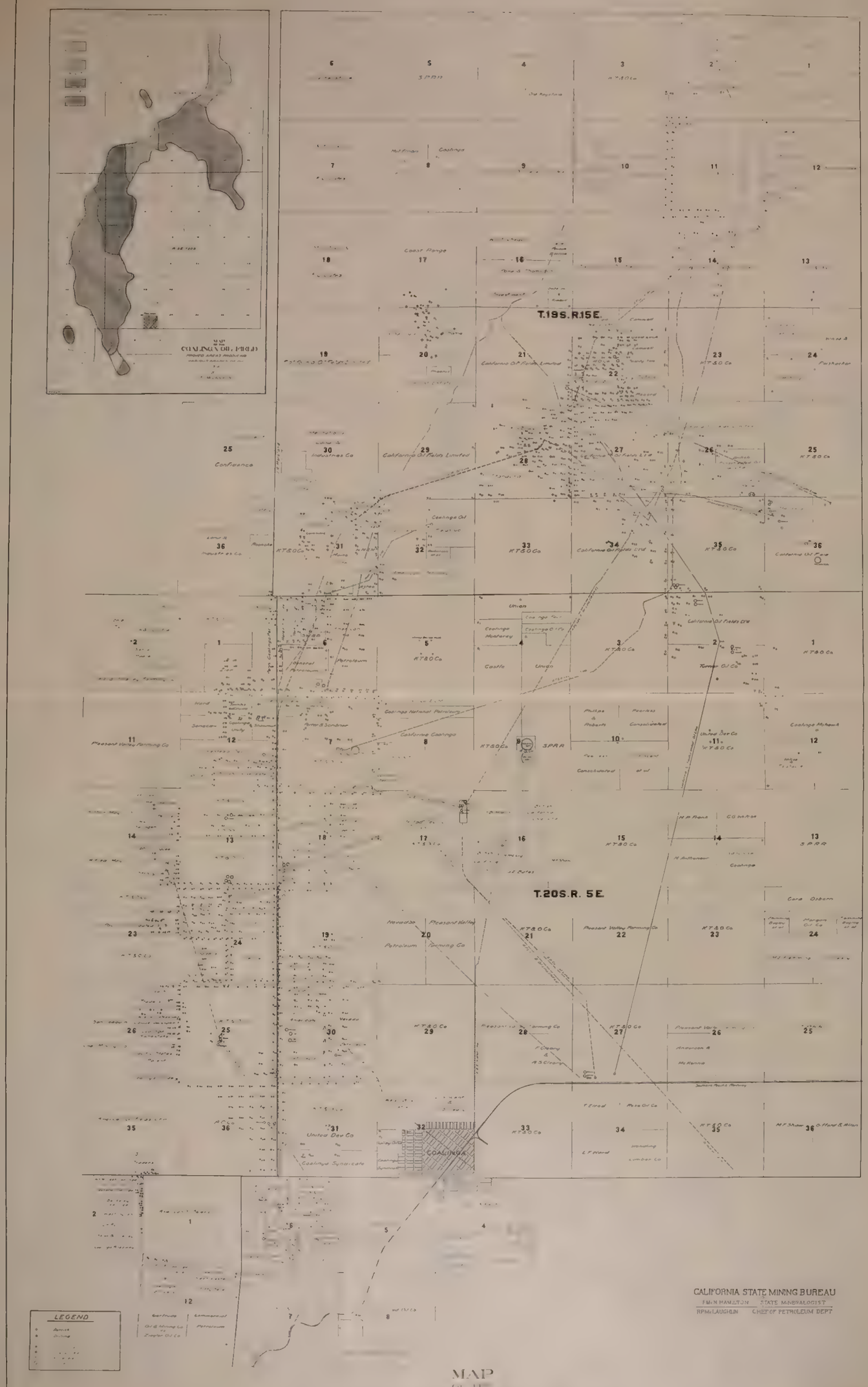
# GEOLOGIC CROSS SECTIONS
# MONTEREY AND SAN LUIS OBISPO COUNTIES

Plate VI



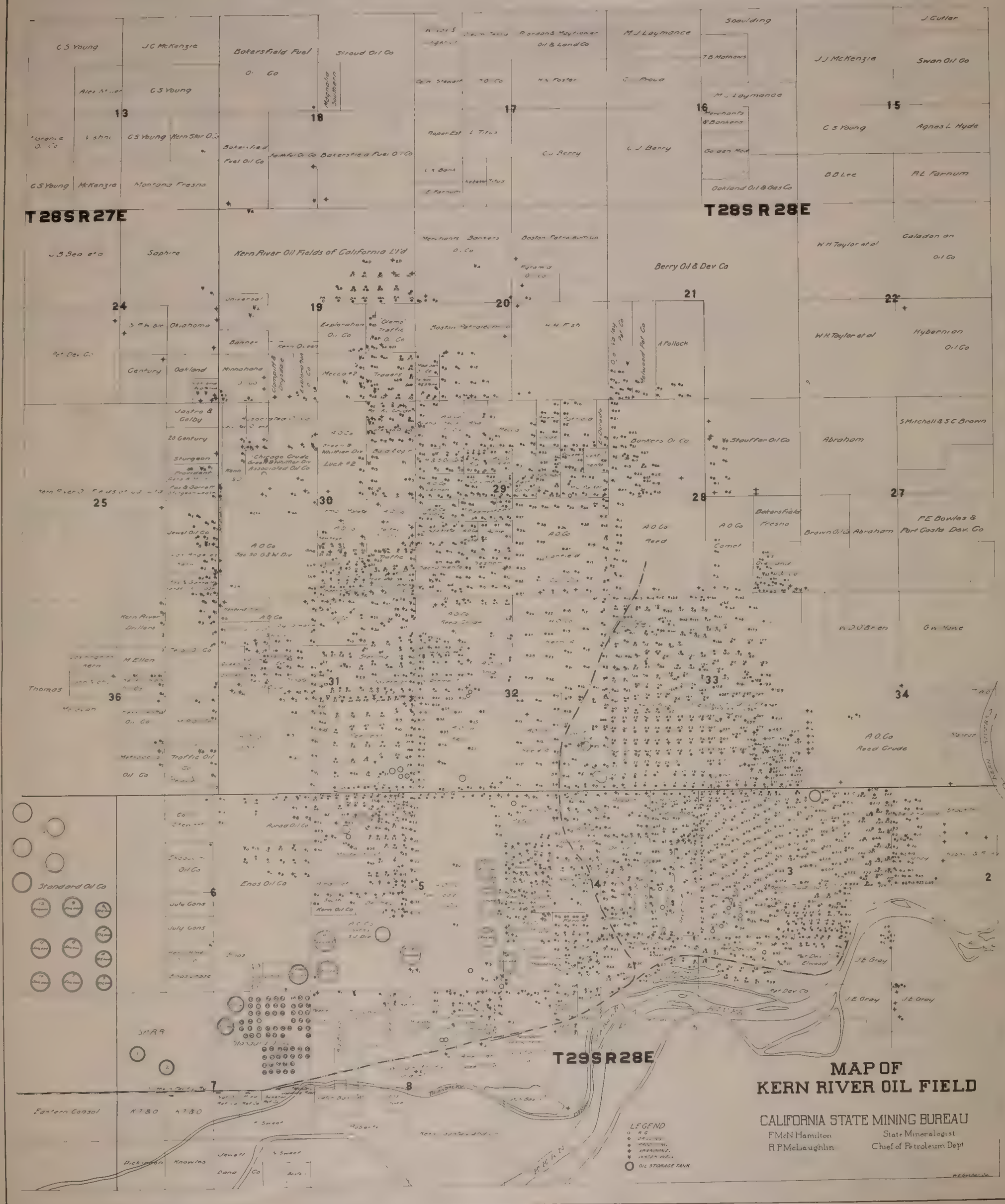

W.E. Golcher, Del.

By C.A. Waring



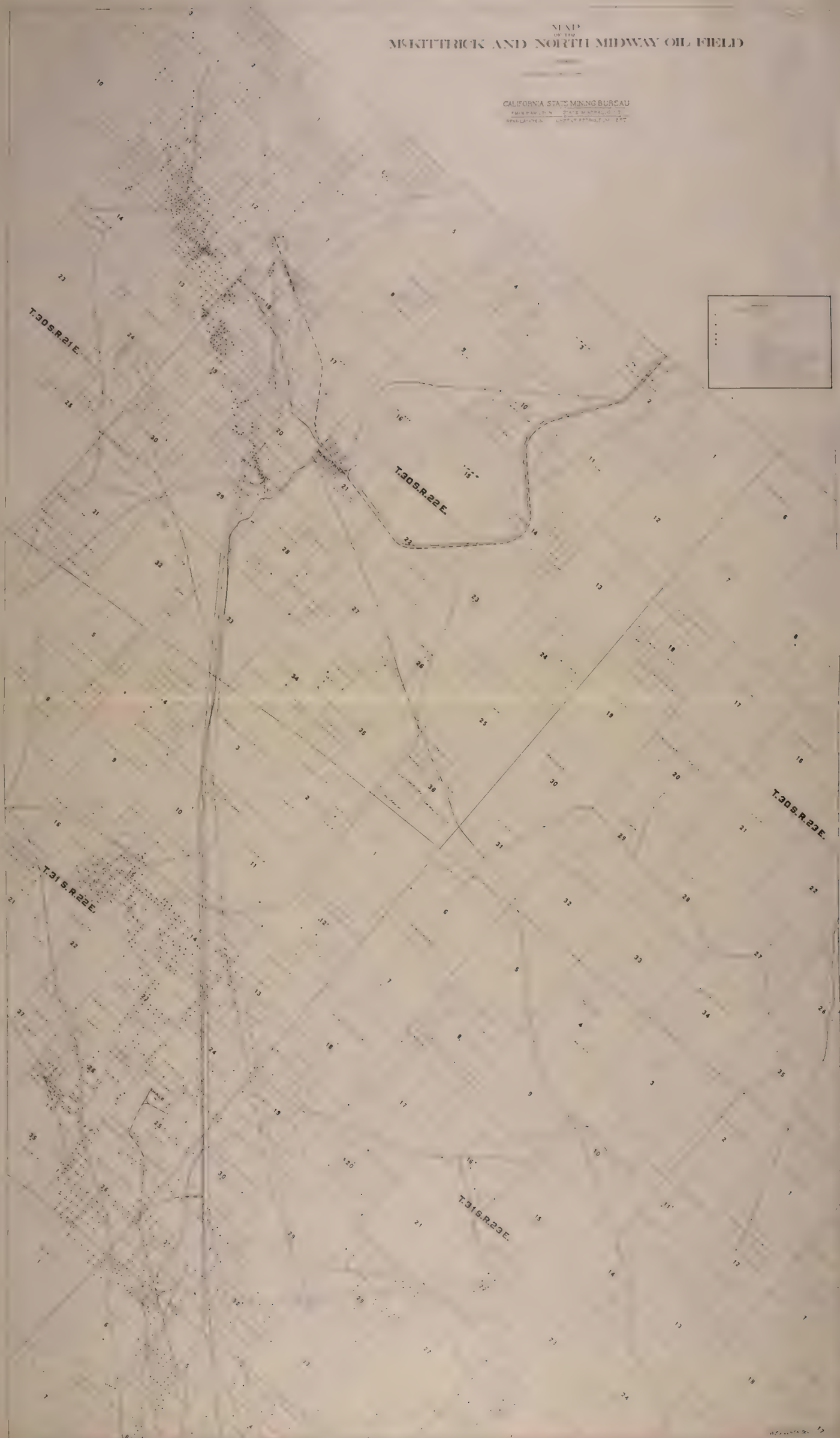

MAP
OF THE
COALINGA OIL FIELD

PLATE VII


T28S R27E
T28S R28E
T29S R28E
Kern River Oil Fields of California Ltd
Bakersfield Fuel Oil Co
Stroud Oil Co
Berry Oil & Dev Co
Oakland Oil & Gas Co
Boston Petroleum Co
Exploration Oil Co
Associated Oil Co
Chicago Crude Oil & Refining Co
Standard Oil Co
Enos Oil Co
Kern Oil Co
Eastern Consol
Dickinson
Knowles
Janoff
Dana Co
Thomas
Traffic Oil Co
Oil Co
Kern River Drillers
Sturgeon
Century
Oakland
Saphire
Oklahoma
Minnehaha
Banner
Luck #2
Reed
Comet
Reed Crude
Abraham
Brown Oil Co
Hybernion Oil Co
Caladonian Oil Co
Swan Oil Co
Agnes L Hyde
Berry
Pollock
Stauffer Oil Co
Bankers Oil Co
Boston Petroleum Co
Pyramid Oil Co
Universal
Jewel Oil Co
Jastro & Colby
Sec 30 G&W Div
Luck #2
Bakersfield
Fresno
Brown Oil Co
Abraham
PE Bowles & Port Costa Dev Co
Gn Hone
Aurad Oil Co
Kern Oil Co
Elwood
J E Gray
S P R R
LEGEND
OIL STORAGE TANK
MAP OF
KERN RIVER OIL FIELD
CALIFORNIA STATE MINING BUREAU
F McN Hamilton State Mineralogist
R P McLaughlin Chief of Petroleum Dept

MAP
OF THE
McKITTRICK AND NORTH MIDWAY OIL FIELD

CALIFORNIA STATE MINING BUREAU



T31S R23E
T31S R24E
T32S R23E
T32S R24E
T12N R24W
T32S R25E
T11N R24W
T12N R23W
T11N R23W
MAP
OF THE
SOUTH MIDWAY AND SUNSET OIL FIELD
-SCALE-
CALIFORNIA STATE MINING BUREAU
F.M.H. HAMILTON STATE MINERALOGIST
H.M. LAUGHLIN CHIEF OF PETROLEUM DEPT
LEGEND
Indicates Surface Drilling
Producing well
Abandoned
Dry well
Water well
Oil storage tanks
Northern Central oil, gas, line
Lost Hills and Sun Oil line
Pipe Supply Co. Oil line
A O Co. Oil line
Standard Oil Co. Oil line
Superior Pipe Line Co. Oil line
PLATE X

California State Mining Bureau
F. McN. Hamilton State Mineralogist.

# MAP OF MIDWAY SUNSET OIL FIELD SHOWING POSITION ABOVE OR BELOW SEA LEVEL OF THE TOP OF PRODUCING OIL ZONES

Plate XI

BY
R. P. McLAUGHLIN

California State Mining Bureau
F.M.N. Hamilton State Mineralogist
R.P. McLaughlin Chief of Petroleum Dept
MAP OF
LOST HILLS BELBIDGE AND DEVIL'S DEN
OIL FIELD
LEGEND
RIG
DRILLING
PRODUCING
WATER WELL
T.25S.R.19E.
T.25S.R.20E.
T.26S.R.21E.
T.26S.R.19E.
T.26S.R.20E.
T.27S.R.21E.
T.27S.R.20E.
T.28S.R.21E.
T.27S.R.19E.
T.28S.R.20E.
T.29S.R.21E.
PRODUCER
PROBABLE STRUCTURE OF LOST HILLS
N.E. SOUCHER, DEL.

CALIFORNIA STATE MINING BUREAU
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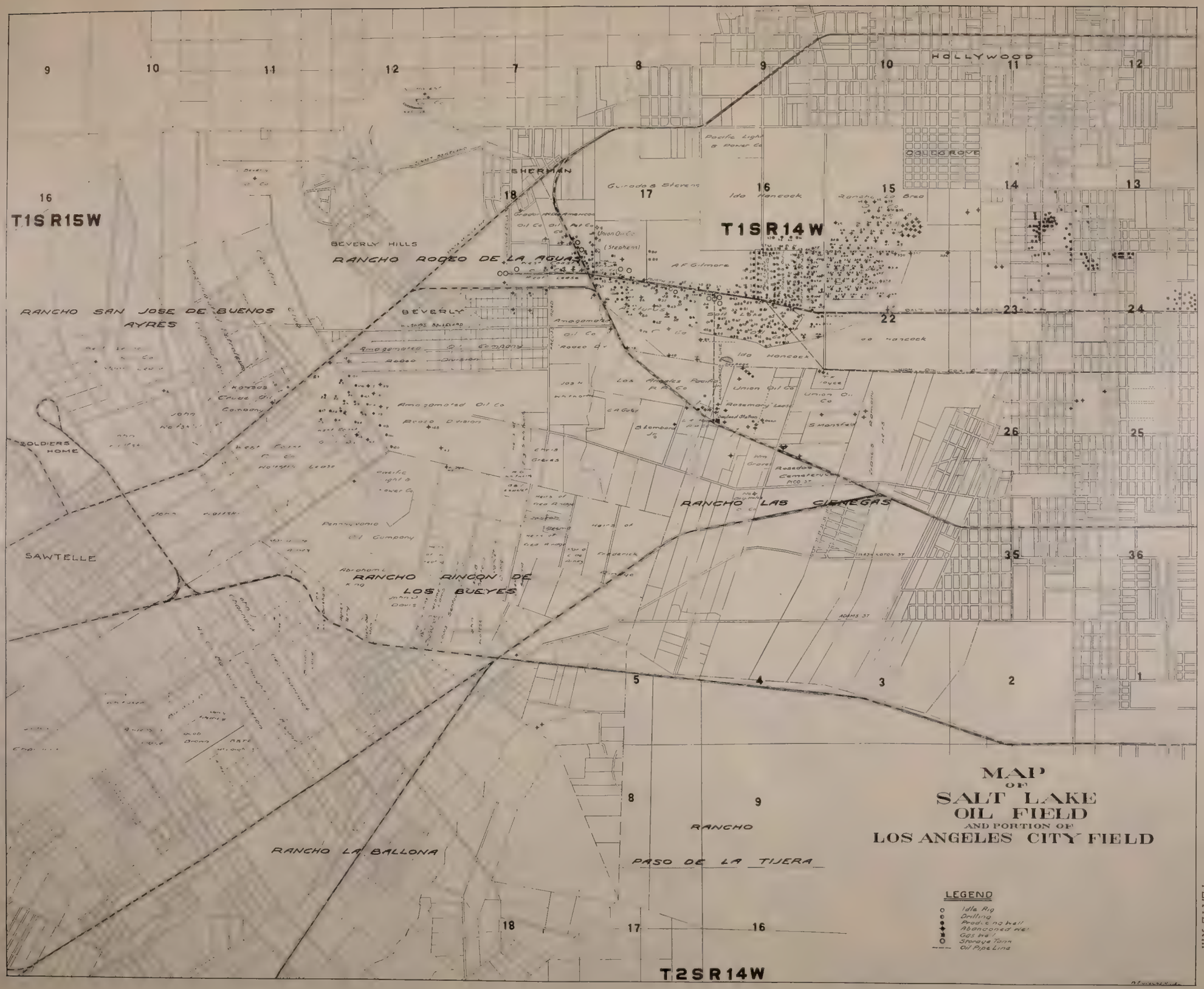
State Mineralogist
R. P. McLaughlin
Chief of Petroleum Dept




MAP OF SALT LAKE OIL FIELD AND PORTION OF LOS ANGELES CITY FIELD

PLATE XIII

MAP
OF
WHITTIER-FULLERTON
(PUENTE AND COYOTE)
OIL FIELDS
CALIFORNIA STATE MINING BUREAU
Hamilton
State Mineralogist
R.P. McLaughlin
Chief of Petroleum Dept
T2S R11W
T2S R10W
T3S R11W
T3S R10W
T.3 S.R.9 W.
RANCHO PASO DE BARTOLO
RANCHO LA PUENTE
RANCHO LA HABRA
RANCHO SANTA GERTRUDES
RANCHO LOS COYOTES
RANCHO SAN JUAN CAJON DE SANTA ANA
WHITTIER
SANTA FE SPRINGS
NORWALK
BREA
CARLTON
BUENA PARK
FULLERTON
RICHFIELD
LOS ANGELES COUNTY
ORANGE COUNTY
LOS ANGELES CO
ORANGE CO
Standard Oil Co
Union Oil Company
(San Sinaro Lease)
Columbia Oil Producing Co
J.N. Hudson
J.N. Hudson & Brady
Union Oil & Transportation Company
Amalgamated Oil Co
Standard Company
F.W. Emery & Co
Solomon Brady
J. Stern Sons
Coyote Hills Oil Co
Andrew Hently
Petroleum Company

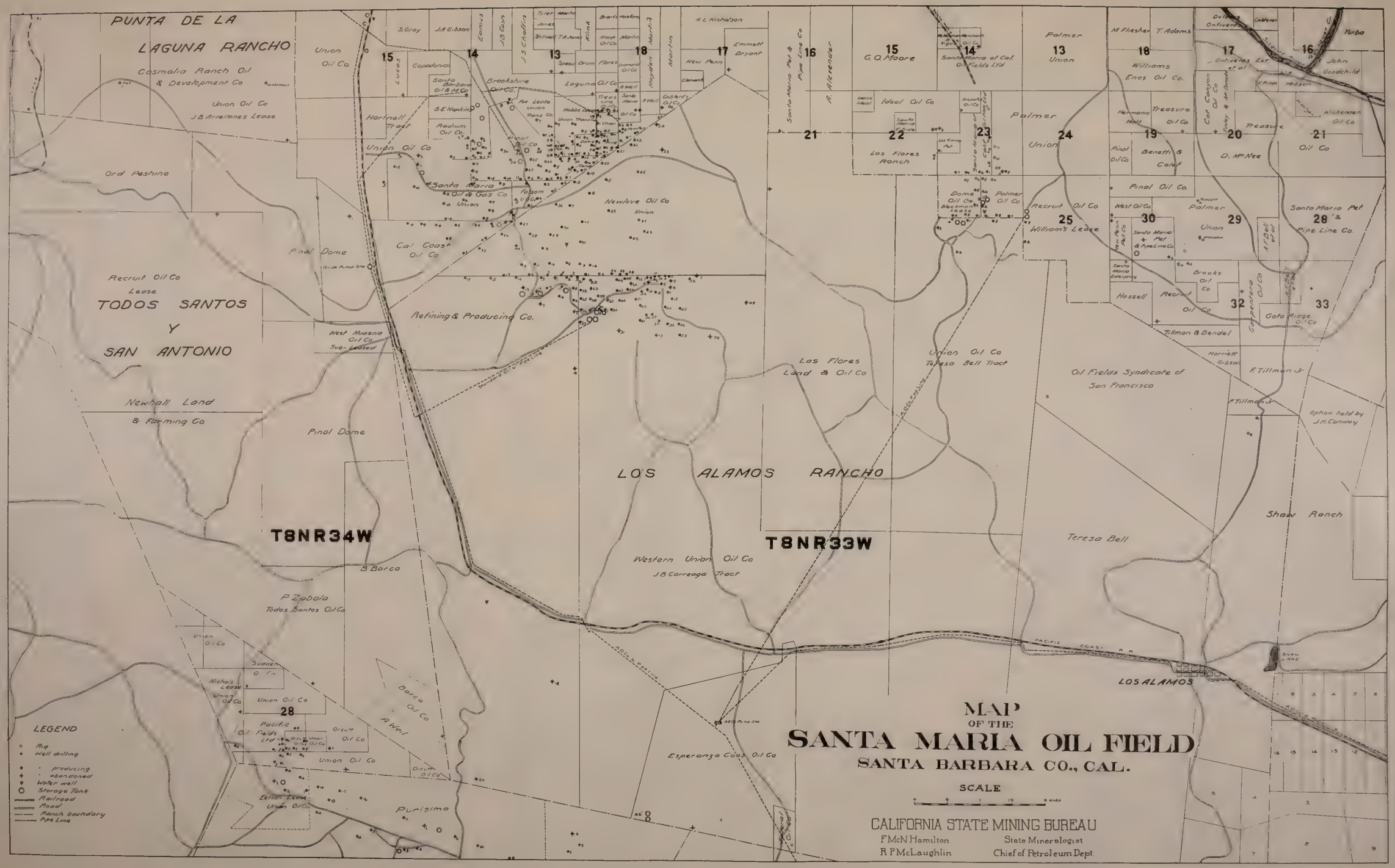
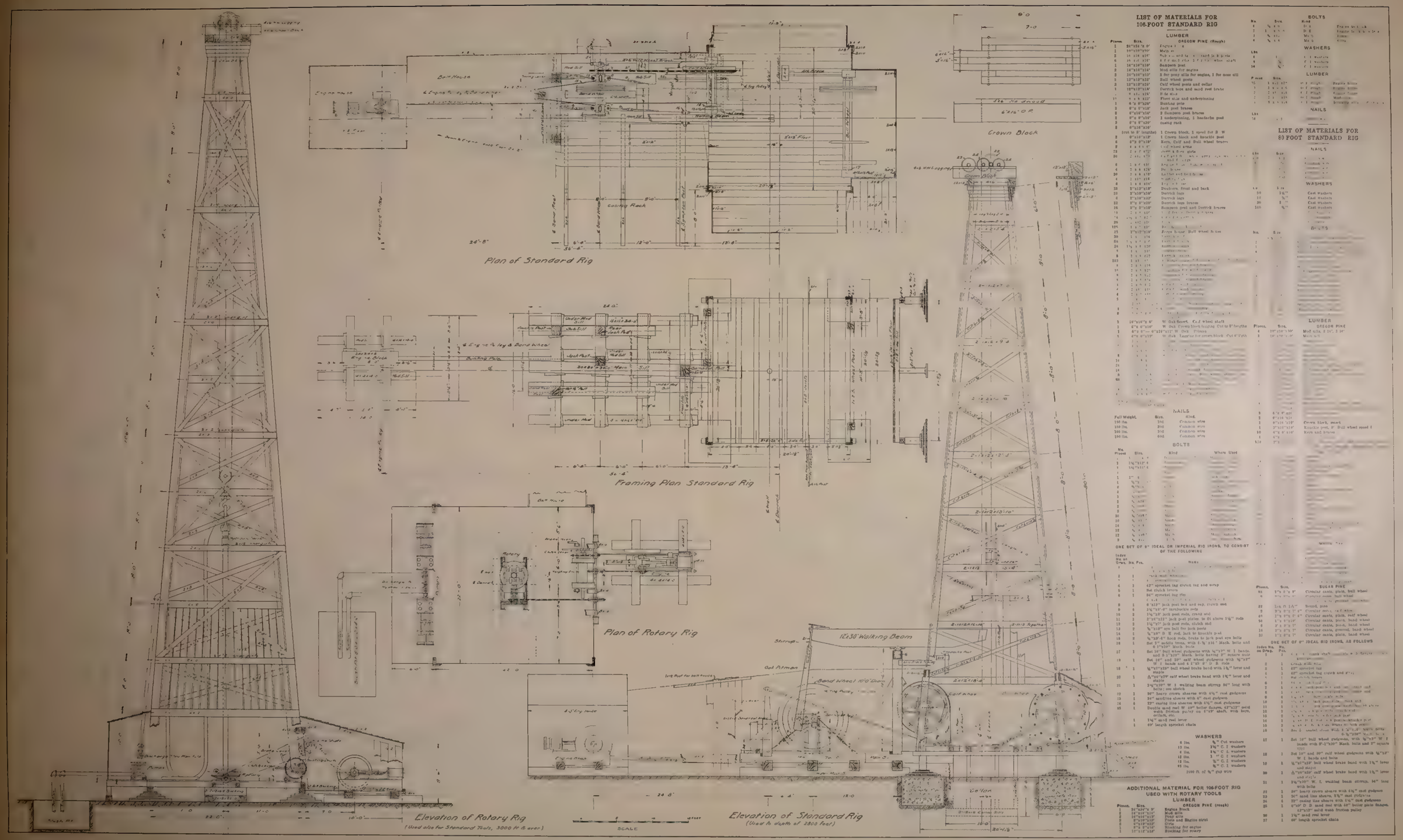
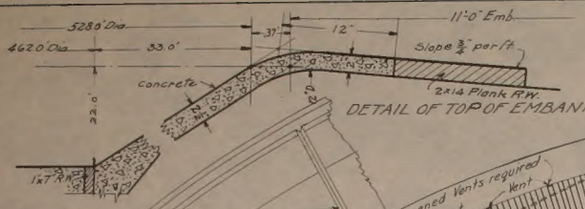

MAP
OF THE
SANTA MARIA OIL FIELD
SANTA BARBARA CO., CAL.
SCALE
CALIFORNIA STATE MINING BUREAU
F McN Hamilton State Mineralogist
R P McLaughlin Chief of Petroleum Dept.
PUNTA DE LA LAGUNA RANCHO
TODOS SANTOS Y SAN ANTONIO
LOS ALAMOS RANCHO
T8NR34W
T8NR33W
LOS ALAMOS
Santa Maria Oil & Gas Co
Refining & Producing Co.
Newlove Oil Co
Cal Coast Oil Co
Pinal Dome
Newhall Land & Farming Co
Los Flores Land & Oil Co
Union Oil Co Teresa Bell Tract
Oil Fields Syndicate of San Francisco
Western Union Oil Co
J B Correaga Tract
Esperanza Coos Oil Co
Teresa Bell
Show Ranch
Palmer Union
Palmer Oil Co
Recruit Oil Co
Williams Lease
Santa Maria Pet & Pipe Line Co
Los Flores Ranch
Ideal Oil Co
Santa Maria of Cal. Oil Fields Ltd
G. O. Moore
Williams Enos Oil Co.
Treasure Oil Co
Benetti & Calif
D. McNee
Pinal Oil Co
Hassell
Brooks Oil Co
Tillman & Bendel
Gato Ridge Oil Co
Option held by J.H. Conway
Pacific Oil Fields Ltd
Circuit Oil Co
Purisima
Barco Oil Co
P Zabala
Todos Santos Oil Co
LEGEND
Rig
Well drilling
producing
abandoned
Water well
Storage Tank
Railroad
Road
Ranch boundary
Pipe Line

PLATE XV

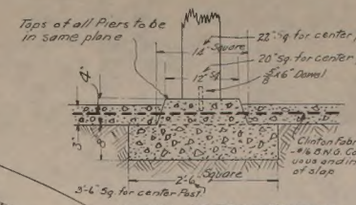

Plan of Standard Rig
Crown Block
Framing Plan Standard Rig
Plan of Rotary Rig
Elevation of Rotary Rig
(Used also for Standard Tools, 3000 ft & over)
Elevation of Standard Rig
(Used to depth of 2800 feet)
12x30" Walking Beam
Band Wheel 10'0" Diam.
Boiler
SCALE
LIST OF MATERIALS FOR 106-FOOT STANDARD RIG
LUMBER
OREGON PINE (Rough)
NAILS
BOLTS
WASHERS
LIST OF MATERIALS FOR 80 FOOT STANDARD RIG
NAILS
WASHERS
BOLTS
LUMBER
OREGON PINE
SUGAR PINE
NAILS
BOLTS
ONE SET OF 8" IDEAL OR IMPERIAL RIG IRONS, TO CONSIST OF THE FOLLOWING
WASHERS
ONE SET OF 8" IDEAL RIG IRONS, AS FOLLOWS
ADDITIONAL MATERIAL FOR 106-FOOT RIG USED WITH ROTARY TOOLS
LUMBER
OREGON PINE (rough)

## Height Schedule

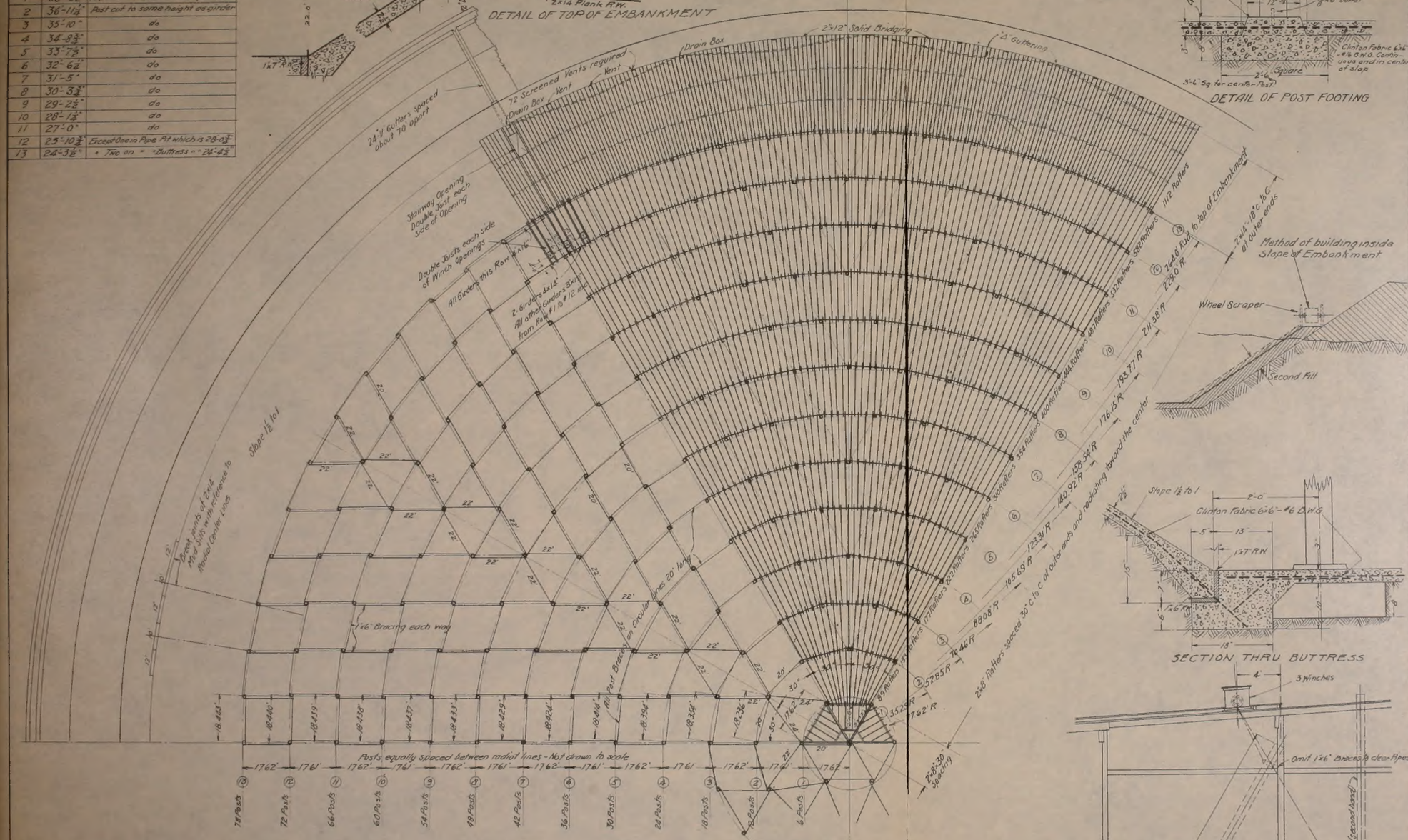
| Row No. | Height | Remarks |
|---|---|---|
| Center | 38'-9 3/8" | |
| 1 | 38'-0 2/8" | Posts cut 4" lower or 37-8 2/8" (about) |
| 2 | 36'-11 3/8" | Post cut to same height as girder |
| 3 | 35'-10" | do |
| 4 | 34'-8 3/8" | do |
| 5 | 33'-7 2/8" | do |
| 6 | 32'-6 2/8" | do |
| 7 | 31'-5" | do |
| 8 | 30'-3 3/8" | do |
| 9 | 29'-2 2/8" | do |
| 10 | 28'-1 3/8" | do |
| 11 | 27'-0" | do |
| 12 | 25'-10 3/8" | Except One in Pipe At Which is 28-0 3/8" |
| 13 | 24'-3 2/8" | " Two on " "Buttress" " 24'-4 3/8" |




DETAIL OF TOP OF EMBANKMENT




DETAIL OF POST FOOTING




## BILL OF MATERIAL

| No. Pcs. | Size | Length | Descript. | Remarks | B.M. Of Pieces | F.B.M. Wed W. | Total F.B.M. |
|---|---|---|---|---|---|---|---|
| 1 | 10x10 | 40' | Rough O.P. | Center Post | 334 | | |
| 6 | 6x6 | 38' | " | Posts - Row #1 | 684 | | |
| 12 | " | 38' | " | " " 2 | 1368 | | |
| 18 | " | 36' | " | " " 3 | 1944 | | |
| 24 | " | 36' | " | " " 4 | 2592 | | |
| 30 | " | 34' | " | " " 5 | 3060 | | |
| 36 | " | 34' | " | " " 6 | 3670 | | |
| 42 | " | 32' | " | " " 7 | 4032 | | |
| 48 | " | 32' | " | " " 8 | 4608 | | |
| 54 | " | 30' | " | " " 9 | 4860 | | |
| 60 | " | 30' | " | " " 10 | 5400 | | |
| 66 | " | 28' | " | " " 11 | 5550 | | |
| 69 | " | 26' | " | " " 12 | 5380 | | |
| 2 | 6x8 | 26' | " | " " 12 | 208 | | |
| 1 | " | 28' | " | " " 12 | 112 | | |
| 78 | " | 26' | " | " " 13 | 8112 | | |
| 78 | 4x16 | 20' | " | Girders - 13 | 8320 | | |
| 2 | 4x14 | 20' | " | " " 12 | 187 | | |
| 466 | 3x12 | 20' | " | " " 1 to #12 Incl | 27960 | | |
| 7 | 3x12 | 18' | " | (H) Half Rafters Ch. to Row #13 (I) Stair Ceiling | 378 | | |
| 1112 | 2x14 | 38'+ | " | Rafters - Row #13 to Embankment | 98500 | | |
| 115 | 2x12 | 12' | " | Solid Bridging on " | 2760 | | |
| 12 | 2x8 | 22' | " | Rafters Row #1 to #2 | 352 | | |
| 3985 | 2x8 | 20' | " | Rafters Ch. to Row #13 (D) Stair Ceiling | 106240 | | |
| 28 | 2x12 | 12' | " | (D) Stair Treads Inc. (E) Outside on Emb. | 672 | | |
| 12 | 2x12 | 14' | " | (B) " Stringers (C) " " | 336 | | |
| 16 | 4x6 | 12' | " | (F) Corbels Row #13 (G) Row #12 | 384 | | |
| 126 | 4x6 | 12' | " | Filler Blocks on Girders Row #13 | 3024 | | |
| 126 | 4x4 | 12' | " | Spacing " " " | 2016 | | |
| 1 | 4x4 | 10' | " | Vent Letter Post in Center | 13 | | |
| 6 | 2x6 | 18' | " | " " Rafters | 108 | | |
| 16 | 1x6 | 16' | " | " " Trim | 128 | | |
| 30 | 1x8 | 10' | " | " " Louvres | 200 | | |
| 18 | 2x4 | 12' | " | " " Studs & Rafters | 144 | | |
| 4 | " | 18' | " | Stair Hand Rail | 48 | | |
| 2 | " | 6' | " | " Opening Cover | 21 | | |
| 560 | 2x3 | 14' | " | Bridging | 3920 | | |
| 34 | " | 14' | " | (H) Vents (G) Stair Cleats | 238 | | |
| | 1x12 | (Random | S.L.S.O.P. | Roof Sheathing 223746" #12% | 25171.4 | | |
| 98 | | 18' | Rough O.P. | Roof Cut diagonally from 49 pcs 6x6 | 2646 | | |
| 35 | 1x12 | 12' | " | Flashing for Walkways | 420 | | |
| 12 | 2x4 | 10' | " | Rafters & 3x12 Girders Ch. to Row #1 | 80 | | |
| 72 | 1x6 | 18' | " | Post Braces on Radial C.L. | 648 | | |
| 912 | " | 20' | " | " " | 9120 | | |
| 132 | " | 22' | " | " " | 1452 | | |
| 12 | " | 24' | " | " " Bat Row #1 & #2 | 144 | | |
| | | | | | 57487 | | |
| 22 | 3x4 | 12' | Rough Dr. | Stringers for Walkways | | 264 | |
| 78 | 2x14 | 12' | " | Mud Sills on Embankment | | 2184 | |
| 78 | 2x14 | 10' | " | Mud Sills on Embankment | | 1820 | |
| 24 | 2x12 | 12' | " | V Trough Guttering | | 576 | |
| 24 | 2x10 | 12' | " | " " " | | 480 | |
| 96 | 1x12 | 14' | " | " " " (T) Cover (S) Slope | | 1344 | |
| 96 | " | 12' | " | " " " (24) Sq. Box (34) Tie (R) Slope | | 1152 | |
| 72 | 1x10 | 12' | " | " " " Slope | | 720 | |
| 24 | " | 14' | " | " " " Slope | | 280 | |
| 146 | 1 1/2x8 | 10' | S.4.S.R.W. | Cut from clear Lumber & dim. | | 1217 | |
| 146 | " | 10' | " | " " " " | | 1217 | |
| 3 | 2x12 | 12' | Rough Dr. | Blocking Outside Stairway | | 72 | |
| | | | | | | 11326 | 58415 |
| 300# | 8d | 2 1/2" | | Cementcoated Nails for Sheathing (2 per ft. B.M.) | | | |
| 300# | 10d | 3" | | " " " " 1x6 Bracing & Ventilator | | | |
| 620# | 16d | 3 1/2" | | " Stairs (24) Bridging (34) Solid Bridging 4.5# | | | |
| | | | | (Blocking & Spacers Row #13) (32) Gutters & (34) | | | |
| 200# | 20d | 4" | | " Steel Straps 8# " V Trenches (20) | | | |
| 1900# | 40d | 5" | | " All Joints to Girders & Joists (20) 12 Joists (30) | | | |
| 400# | 60d | 6" | | " All Girders to Posts | | | |
| 200# | 10d | 3" | | Common Wire Nails for Temporary Construction &c | | | |
| 200# | 20d | 4" | | " " " " " | | | |
| 200ft | #15 | | | Galv. Wire for tie wiring Reinforcing Rods in Buttress | | | |
| 32 | Squares | | | Ready Rock Roofing | | | |
| 2238 | " | | | Sanded Rubber Roofing with Cement & Large head Nails | | | |
| 40 | Tons | | | Asphalt | | | |
| 336 | Cu. Yds. | | | Roofing Gravel | | | |
| 3 | 12" | | | Clamps for Outlet Pipes | | | |
| 3 | 8" | | | " " Drain " | | | |
| 560 | 3/4" x 1/4" | 18" | | Soft Steel Straps for Girders | | | |
| 90 | 5/8" | 9" | | Machine Bolts " " | | | |
| 480 | " | 7" | | " " " | | | |
| 575 | " | | | Cut Washers for 5/8" Bolts | | | |
| 575 | " | 6" | | Domes | | | |
| 1 Roll | 30" | 100' | | Wire Screen 12 Mesh #24 Galv'd for 72 Vents & edge of Roof | | | |
| | 24" | 100' | | " " " " " In Back of Louvres in Vent Tr. | | | |
| 3 | Winches complete | | | | | | |
| 4 | 1" x 18" Anchor Bolts (Sounding Well Base) | | | | | | |
| 2 | 1" x 14" " " " with Straps & Bolts (Stairs) | | | | | | |
| 15 | Joints 12" dia Std. Pipe about 20' each with Couplings | | | | | | |
| 12 | 12" Std. Companion Flanges and Bolts | | | | | | |
| 5 | Joints 8" dia Std. Pipe about 20' each with Couplings | | | | | | |
| 6 | 12" Std. Screwed Elbows | | | | | | |
| 3 | 12" x 27" Swing Outlet Pipes | | | | | | |
| 1 | Base for Sounding Well | | | | | | |
| 6 | 12 x 6 long Std. Pipe Nipples | | | | | | |
| 1 | 8 1/4" Second Hand Casing 30' long for Sounding Well | | | | | | |
| 3 | pair 14" Heavy Strap Hinges with Screws | | | | | | |
| 2 | 8" Std. Companion Flanges and Bolts | | | | | | |
| 3 | 12" " Straight Way Valves Flanged - Outside Screw & Yoke - Crane # 465 | | | | | | |
| 1 | 8" " " " " " " " " " | | | | | | |

# PLANS FOR 750,000 BBL. OIL RESERVOIR OF EARTH CONCRETE LINED

CALIFORNIA STATE MINING BUREAU

F. McN. HAMILTON — STATE MINERALOGIST

R. P. McLAUGHLIN — CHIEF OF PETROLEUM DEPT.

W. E. GOLCHER, DEL.

CALIFORNIA STATE MINING BUREAU
F. McN. Hamilton — State Mineralogist
R. P. McLaughlin — Chief of Petroleum Dept

# MAP OF CALIFORNIA OIL AND GAS PIPE LINES AND FIELDS

Plate XVIII

## Geologic Record of California

(Continued from Front Cover)

A second great mass of clastic sediments is seen in the Tertiary sandstones of the Coast Ranges, which extend nearly the entire length of the state, and have a total thickness of about fifteen thousand feet, although not all of this at any one place. A remnant of this series is seen along the western flank of the Sierra Nevada in the marine and brackish-water Ione formation, and the upland equivalent is seen in the Auriferous Gravels.

A third great mass of sandstones is found in the Cretaceous of the Coast Ranges, where a thickness of about thirty thousand feet was deposited. This thickness surpasses by far that of the Tertiary sandstones, but the areal extent is much less. These, too, overlapped on the foot of the Sierra Nevada.

Smaller masses of sandstone, now largely changed to quartzite, are seen in the early Mesozoic and Paleozoic formations of the Sierra Nevada and Coast Ranges, but nowhere forming extensive surface areas.

On the western flank of the Sierra Nevada, throughout the Gold Belt, there are in the late Paleozoic and in the late Jurassic thick beds of tuffs, or volcanic ash, now altered to greenstone schists. These in places have a thickness of several thousand feet, but do not form considerable areas of the surface rocks.

*Organic sediments.*—These do not make much of a figure on the areal map of the state, but play a large part in its economic history. They are limestones, siliceous shales, and plant accumulations in the form of coal or lignite.

The limestones are entirely of organic origin, with the exception of some smaller occurrences of late spring deposits, or calcareous tufa, which, however, are large enough to be used in the manufacture of cement.

The great masses of limestone are confined to the Paleozoic and early Mesozoic, though as late as the middle of the Jurassic period there are some large beds of limestone. They are formed of ground-up shells, corals, and foraminifers that lived in quiet, clear waters, but are now largely crystalline, most of the evidence of their organic origin having been destroyed in the great mountain-making revolutions that have passed over them. The formation of limestone on a large scale in California was confined to epochs that we know from other evidence were warm, and also to epochs when sheltered, clear seas covered portions of the state. In such seas corals and foraminifers abounded, and the evidence of their rock-forming activity is still visible in the coral reefs of the Paleozoic and Triassic, and the Fusulina limestone of the Carboniferous.

From the middle of the Mesozoic up to the Eocene it was still warm enough at times for reef-building corals, and foraminifers to have flourished in the seas of California; but the warm epoch of the Middle Jurassic was a time of igneous activity, and during the Cretaceous there was too much sand and mud poured into the water for these organisims to find a favorable habitat.

Limestones, at least in part formed by corals, have a thickness of several thousand feet in the Cambrian of Inyo County, but the areal extent is unknown. The Devonian of Shasta and Siskiyou counties shows coral reef rock to the thickness of several hundreds of feet, of small area. These are all surpassed in the great masses of Carboniferous limestone, of the White Mountains, the western flank of the Sierra Nevada, and the Klamath Mountains, where the lenticular beds sometimes attain a thickness of two thousand feet.

The Santa Lucia limestone, in the Coast Ranges, of doubtful Paleozoic age, also occur in large beds, amounting to several hundred feet in thickness, now changed to marble.

The Upper Triassic of Shasta and Plumas counties has lenses of limestone in places four or five hundred feet thick, forming important topographic features, and largely formed by the agency of corals.

The Franciscan series of the Coast Ranges has similar limestone masses of lenticular form, amounting in places to a few hundred feet in thickness, and wholly destitute of fossils, except a few traces of foraminifers.

The Cretaceous lacks limestone beds, except a local accumulation of shell limestone in the Knoxville formation of Colusa County, where a thickness of only a few feet is developed.

The Eocene of the Santa Cruz Mountains has some thin beds of limestone, and the Miocene of Santa Barbara, San Luis Obispo, and Orange counties has shell limestone amounting to as much as fifty feet in thickness. With the exception of these local occurrences there are no limestone masses in the marine beds of California from the middle of the Jurassic to the Quaternary, the Jurassic and Knoxville being characterized by thick beds of shale, and the other formations, from the Horsetown up, by enormous beds of sandstone.

*Siliceous organic sediments.*—Among the most remarkable features of the stratigraphy of California are the thick beds of siliceous organic sediments. In the Monterey shale of the Middle Tertiary in the Coast Ranges such sediments are extensively developed, and in places reach a thickness of five thousand feet. These are not shales in the ordinary sense, for they are chiefly organic in origin, the remains of microscopic diatoms and radiolaria. Similar deposits are known also in the Eocene of the middle Coast Ranges, but on a smaller scale. *These organic siliceous shales are of great economic importance, for they have furnished nearly all of the petroleum of California.*

Similar masses of siliceous organic sediments are known in the Coast Ranges in the Franciscan formation, of the earlier Mesozoic, but they are no longer shales, rather hard, flinty rocks, with the organic matter long since removed, and the fossil tests of radiolaria almost entirely destroyed, so that the rocks now show little resemblance to organic sediments.

In the Mother Lode region of the Sierra Nevada there are somewhat similar chert masses, in beds supposed to be Jurassic in age. These too are probably of radiolarian origin. In the Middle Triassic of Shasta County a series of siliceous shales almost without sand grains, and about two thousand feet thick, likewise was probably formed partly from the shells of siliceous organisms.

The Lower Carboniferous and the Devonian of Shasta and Siskiyou counties also contain many hundreds of feet of fine-grained so-called siliceous shales that are probably, at least in part, metamorphosed organic sediments. Shells of diatoms and radiolaria are extremely rare in all these older beds, but organic silica is very soluble, and even a slight degree of metamorphism destroys the delicate tests, and thus obliterates the evidence of their origin.

*Coal deposits.*—During the Eocene epoch plant remains accumulated to a considerable extent in the swamps of the old embayment of California, especially along the western flank of the Sierra Nevada, near Ione, the Coast Range island area of the Mt. Diablo region, and in the middle Coast Ranges of Monterey, San Benito, and Fresno counties. These leaf beds have since been compacted into lignite, and in a few places into true coal.

*Chemical deposits.*—In Kern, San Bernardino, San Diego, and Inyo counties there are extensive chemical precipitates of salt, soda, borax, and gypsum, concentrates from the old lakes and salt pans of the arid region, from Tertiary up to the present. The areal extent is not large, but they are scattered over enormous stretches of country, and are of great present or prospective economic importance.

### Comparative Rate of Formation of Calcareous and Arenaceous Sediments.

Most estimates of the relative rate of formation of calcareous and arenaceous sediments are merely conjectural. A method is here suggested by which a somewhat more reliable estimate may be made. It is based on the comparative thickness of a single formation in the Californian region with that of the same formation in another region. This can be reliable only when the entire formation is represented in both regions compared, and when the conditions are reversed. We have two such cases in the Carboniferous of California and the western part of the Mississippi Valley region, and in the Cretaceous of the same regions.

The McCloud limestone of California represents nearly the whole Coal Measures, with only a small part of the upper division absent, and it is all rather pure limestone with a thickness of about two thousand feet. The Coal Measures section of Arkansas embraces all but the uppermost part of the formation, and the thickness is approximately twenty thousand feet, if we leave out the Poteau group, which is probably higher than the top of the McCloud limestone of California. This would indicate that it takes approximately ten times as long for a foot of limestone to form as it does for a foot of sandstone.

A similar conclusion may be drawn from a comparison of the Cretaceous sections of the two regions; and here the West Coast has an arenaceous section, while the Cretaceous rocks of the Southwest are in places entirely calcareous, a reversal of conditions from those of the Carboniferous.

The Cretaceous section of northern California shows a thickness of about thirty thousand feet, all sandy, and evidently deposited in shallow water in a synclinal trough, just as was the Coal Measures sandstone of Arkansas and Oklahoma. The Cretaceous beds of the Southwest, ordinary marls and chalky limestones, have, where not mixed with sandy deposits, a thickness of about three thousand feet. This again indicates that it takes about ten times as long for the accumulation of a foot of limestone to accumulate under ordinary conditions as it does for a foot of sandstone.

Of course the thicknesses vary in different parts of the same region, and at best are only rough estimates; also we cannot be sure in widely separated regions whether we have exactly the same geologic units represented in the sections compared. Also it is not at all likely that all limestones or all sandstones are laid down at even approximately the same rates. Still the agreement of the figures is too great to be accidental.

If we accept this ratio of ten to one for rates of formation of sandstone and limestone, we have a means of estimating the relative length of time consumed in laying down the rocks of the various formations, even when their lithologic character is different. Thus the Triassic of the Great Basin region, with only four thousand feet of calcareous sediments, probably represents at least one-third longer time than the Cretaceous of California, with its thirty thousand feet of sandy beds. The Tertiary formations of California, which are about fifteen thousand feet thick, represent about one-half the time of the Cretaceous, which is twice as thick, and about one-third of the time of the Triassic of this region, which is hardly one-fourth as thick. The other formations are too incompletely developed here, or too varied in composition, for any reliable estimate of their relative length of time to be made. The Carboniferous section is complete, but has sandstones, shales, limestones, and tuffs alternating in such a manner that, with our present knowledge, it is hardly possible to estimate the entire system in terms of limestone.

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## Fossils Characteristic of California Formations

(Continued from Front Cover)

### IONE (Upper Eocene).

22. *Venericardia planicosta var. ionense* Waring. Right valve from the Ione (Umpqua) formation of Umpqua Valley, Oregon. Found also in the Ione at Merced Falls, and with *Turritella merriami* at Thermalito, California. This species can be distinguished, in mature form, by its obsolete ribs. Collected by H. Hannibal in 1914.

23. *Turritella merriami* Dickerson. From the Ione formation two-thirds of a mile north of Thermalito hospital at the foot of south Table Mountain, Thermalito, California. Collected by H. Hannibal in 1914. Occurs with *Venericardia ionense*. This species also occurs in the Ione at Corral Hollow, Alameda Co., California.

### SAN LORENZO (Oligocene).

24. *Aturia angustata* Conrad. From the San Lorenzo horizon of the Astoria Series (Middle Oligocene) one-half mile above the mouth of Green Creek, Holcomb, Washington. Collected by H. Hannibal in 1912. A characteristic species in the San Lorenzo formation of California.

25. *Nucula dalli* Arnold. Left valve from the San Lorenzo (Oligocene) shales of the bluffs along San Lorenzo River, three and one-half miles above the mouth of King's Creek, Santa Cruz Co., California. Collected by Ralph Arnold.

26. *Turcicula sanctacruzana* Arnold. From shales of the San Lorenzo formation in the bluffs along the San Lorenzo river at Doherty's mill, Boulder Creek, Santa Cruz Co., California. Collected by R. Anderson and F. W. Nobs.

### VAQUEROS (Upper Lower Miocene).

27. *Pecten magnolia* Conrad. Left valve from the Vaqueros formation at Nojoqui Rancho near Alisal line, Santa Barbara Co., California. Collected by R. B. Moran.

28. *Turritella inezana* Conrad. From the Vaqueros formation of Canal de Pietro, San Luis Obispo Co., California. Collected by R. B. Moran.

### MONTEREY (Lower Middle Miocene).

29. *Chione temblorensis* Anderson, F. M. Left valve from the Monterey sandstone formation at Barker's Ranch, Fresno Co., California. Collected by H. M. Anderson.

30. *Agasoma kernianum* Cooper. From the Monterey sandstone formation, associated with *Turritella ocoyana*, at Barker's Ranch, Fresno Co., California. Collected by H. M. Anderson.

31. *Pecten pechami* Gabb. Left valve from the Monterey shale formation along Slate Creek, near Castle Rock Ridge, San Mateo Co., California. Collected by Newsom and Morrison.

32. *Arca obispoana* Conrad. Right valve from the Etchegoin formation of the Kreyenhagen Hills in Sec. 22, T. 21 S., R. 16 E.; Coalinga District. Collected by R. N. Ferguson.

33. *Pecten andersoni* Arnold. Right valve from the Monterey sandstone formation at Barker's Ranch, Fresno Co., California. Collected by H. M. Anderson.

34. *Turritella ocoyana* Conrad. From the Monterey sandstone formation at Barker's Ranch, Fresno Co., California. Collected by H. R. Johnson.

### PUENTE (Upper Middle Miocene).

35. *Pecten pedroanus* Arnold. Drawing of the exterior impression of the left valve of a specimen from the Puente shales west of Eastlake Park, Los Angeles Co., California. The interior of the valve has a few broad concentric ribs as figured in U. S. Geol. Surv., Bull. 309, pl. XXXVI, fig. 5; while the exterior has fine radiating and concentric ribs. Collected by C. A. Waring in May, 1914.

### SANTA MARGARITA (Lower Upper Miocene).

36. *Tamiosoma gregaria* Conrad. From the Santa Margarita formation of Wildhorse Canyon, Monterey Co., California. Collected by R. B. Moran in 1908.

37. *Astrodapsis anticelli* Conrad. From the Santa Margarita formation three miles north of San Lucas on the east side of Salinas Valley, Monterey Co., California. Collected by R. B. Moran in 1907.

38. *Pecten estrellanus* Conrad. Right valve from the Santa Margarita formation of Goat Canyon, Salinas Valley, Monterey Co., California. Collected by R. B. Moran in 1908.

39. *Pecten crassicardo* Conrad. Right valve from the upper Santa Margarita (Jacalitos?) formation of Indian Creek, San Luis Obispo Co., California. Collected by J. O. Lewis.

### JACALITOS (Middle Upper Miocene).

40. *Pecten oweni* Arnold. Left valve from the Jacalitos formation of Sec. 23, T. 21 S., R. 14 E., Coalinga district, Fresno Co., California. Collected by R. N. Ferguson in 1908.

41. *Trophon ponderosus* Gabb. From the Jacalitos formation of Rancho Rico Canyon, Monterey Co., California. Collected by R. B. Moran.

### FERNANDO AND ETCHEGOIN (Upper Miocene and Marine Pliocene).

42. *Pecten healeyi* Arnold. Right valve from the Etchegoin (San Diego) formation of Pacific Beach, San Diego Co., California. Collected by Ralph Arnold.

43. *Scutella ashleyi* Arnold. From the Fernando formation southeast of Carrega, Santa Barbara Co., California. Collected by J. O. Lewis in 1910.

44. *Pecten wattsi* Arnold. Right valve from the upper Etchegoin formation at Kreyenhagen's ranch, Sec. 32, T. 21 S., R. 16 E., Fresno Co., California. Collected by R. N. Ferguson in 1908.

45. *Arca trilineata* Conrad. Left valve from the Etchegoin (Purissima) formation at Capitola bluffs, Santa Cruz Co., California. Collected by H. Hannibal and C. A. Waring in 1913.

46. *Pecten bellus* Conrad. Right valve from the Fernando of the Santa Clara River Valley, Ventura Co., California. Collected by R. B. Moran.

### SAN PEDRO (Pleistocene).

47. *Pecten caurinus* Gould. Right valve from the lower San Pedro formation of Deadman's Island, Los Angeles Co., California. Collected by Dr. J. P. Smith in 1906.

48. *Pisania fortis* Carpenter. From the lower San Pedro formation of Signal Hill, near Long Beach, Los Angeles Co., California. Collected by C. A. Waring in May, 1914.

49. *Pecten jordani* Arnold. Right valve from the lower San Pedro formation at Timm's Point, San Pedro, California. Collected by Ralph Arnold.

50. *Turritella jewetti* Carpenter. From the lower San Pedro formation of Deadman's Island, San Pedro, Los Angeles Co., California. Collected by Hon. Delos Arnold.

51. *Cancellaria tritonidea* Gabb. From the upper San Pedro formation at San Pedro, Los Angeles Co., California. Collected by Hon. Delos Arnold.

52. *Chione gnidia* Broderip and Sowerby. Left valve from the upper San Pedro formation at Signal Hill, near Long Beach, Los Angeles Co., California. Collected by H. Hannibal in 1913.

53. *Cardium procerum* Sowerby. From the upper San Pedro formation of San Pedro, Los Angeles Co., California. Collected by Hon. Delos Arnold.